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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
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GATES & COOPER LLP
HOWARD HUGHES CENTER
6701 CENTER DRIVE WEST, SUITE 1050
LOS ANGELES, CA 90045

EXAMINER

SONG, MATTHEW J

ART UNIT	PAPER NUMBER
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1765

13

DATE MAILED: 07/18/2003

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary

Application No.

09/922,122

Applicant(s)

MARCHAND ET AL.

Examiner

Matthew J Song

Art Unit

1765

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133).
- Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

- 1) ☒ Responsive to communication(s) filed on 01 May 2003.
- 2a) ☒ This action is **FINAL**. 2b) ☐ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

- 4) ☒ Claim(s) 1,2,4-9 and 11-39 is/are pending in the application.
- 4a) Of the above claim(s) 18-34 is/are withdrawn from consideration.
- 5) ☐ Claim(s) _____ is/are allowed.
- 6) ☒ Claim(s) 1,2,4-9,11-17 and 35-39 is/are rejected.
- 7) ☐ Claim(s) _____ is/are objected to.
- 8) ☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

- 9) ☐ The specification is objected to by the Examiner.
- 10) ☐ The drawing(s) filed on _____ is/are: a) ☐ accepted or b) ☐ objected to by the Examiner.
- Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).
- 11) ☐ The proposed drawing correction filed on _____ is: a) ☐ approved b) ☐ disapproved by the Examiner.
- If approved, corrected drawings are required in reply to this Office action.
- 12) ☐ The oath or declaration is objected to by the Examiner.

Priority under 35 U.S.C. §§ 119 and 120

- 13) ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
- a) ☐ All b) ☐ Some * c) ☐ None of:
1. ☐ Certified copies of the priority documents have been received.
2. ☐ Certified copies of the priority documents have been received in Application No. _____.
3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).
- * See the attached detailed Office action for a list of the certified copies not received.
- 14) ☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. § 119(e) (to a provisional application).
- a) ☐ The translation of the foreign language provisional application has been received.
- 15) ☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. §§ 120 and/or 121.

Attachment(s)

- 1) ☒ Notice of References Cited (PTO-892)
- 2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
- 3) ☐ Information Disclosure Statement(s) (PTO-1449) Paper No(s) _____.
- 4) ☐ Interview Summary (PTO-413) Paper No(s). _____.
- 5) ☐ Notice of Informal Patent Application (PTO-152)
- 6) ☐ Other: _____.

DETAILED ACTION

Claim Rejections - 35 USC § 112

1. The following is a quotation of the first paragraph of 35 U.S.C. 112:

The specification shall contain a written description of the invention, and of the manner and process of making and using it, in such full, clear, concise, and exact terms as to enable any person skilled in the art to which it pertains, or with which it is most nearly connected, to make and use the same and shall set forth the best mode contemplated by the inventor of carrying out his invention.

2. Claim 36 is rejected under 35 U.S.C. 112, first paragraph, as failing to comply with the written description requirement. The claim(s) contains subject matter which was not described in the specification in such a way as to reasonably convey to one skilled in the relevant art that the inventor(s), at the time the application was filed, had possession of the claimed invention. Claim 36 recites, "a graded gallium nitride layer is at least approximately 0.55 um thick" in lines 1-2. The instant specification merely teaches a film with a thickness of approximately 0.55 um thick. The instant specification does not teach the graded layer is **at least** approximately 0.55 um thick; there only support for the one thickness and not range claimed.
3. Claim 38 is rejected under 35 U.S.C. 112, first paragraph, as failing to comply with the written description requirement. The claim(s) contains subject matter which was not described in the specification in such a way as to reasonably convey to one skilled in the relevant art that the inventor(s), at the time the application was filed, had possession of the claimed invention. Claim 38 recites, " the graded gallium nitride layer has a net stress below a stress required for crack generation in the graded gallium nitride layer" in lines 1-3. The instant specification does not teach the stress of the graded gallium nitride layer. The instant specification merely teaches stresses of GaN films. The instant specification does not provide support for **graded** GaN layers.

4. Claim 39 is rejected under 35 U.S.C. 112, first paragraph, as failing to comply with the written description requirement. The claim(s) contains subject matter which was not described in the specification in such a way as to reasonably convey to one skilled in the relevant art that the inventor(s), at the time the application was filed, had possession of the claimed invention. Claim 39 recites the “stress required for crack generation in the graded graded gallium nitride layer, wherein the stress required for crack generation is less than about 400 Mpa in tension” in claim 38 and lines 1-2. The instant specification merely teaches GaN films exhibit cracking when the tensile stress exceeds 400 Mpa. The instant specification does not provide support for **graded** GaN layers.

Claim Rejections - 35 USC § 103

5. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

6. Claims 1,2, 4-9 and 11-39 are rejected under 35 U.S.C. 103(a) as being unpatentable over Edmond et al (US 5,739,554) or Redwing et al (US 5,874,747) in view of Goetz et al (US 6,441,393).

Edmond et al discloses a buffer layer **42** can comprise a graded layer of AlGa_N that is substantially entirely aluminum nitride where it meets the SiC substrate **42** and then is

Art Unit: 1765

progressively graded with increasing amounts of gallium until it is substantially entirely gallium nitride at its upper surface where it meets the n-type layer of gallium nitride **43** (Fig 2 and col 7, ln 1-67), this progressively graded layer reads on applicant's varying composition of substantially continuous grade.

Redwing et al discloses a method of forming a graded (Al,Ga)N buffer on a SiC substrate wherein the Al content is graded from AlN at the substrate to GaN at the top, this reads on applicant's varying composition of a substantially continuous grade. Redwing et al is also discloses an initial TMAI flow rate and a final flow rate were chosen that would give the same growth rate and TMAI flow rate is supplied without interruption (Example V and Fig 20). Redwing et al also discloses the graded layer could also be made of (Al,In)N or (Al,Ga,In)N (col 19, ln 1-67). Redwing et al also discloses a compositionally graded GaN layer may comprise a compositionally graded $\text{Al}_x\text{Ga}_{1-x}\text{N}$ buffer layer between gallium nitride and a silicon carbide layer and the buffer layer is compositionally graded from an interface of the buffer layer with a silicon carbide layer at which x is 0 to an interface of the buffer layer with a gallium nitride layer at which x is 1 (col 7, ln 1-67).

Edmond et al or Redwing et al disclose a Silicon carbide substrate. Edmond et al or Redwing et al does not discloses a silicon substrate.

In a method of forming semiconductor devices with doped III-V nitride layers, note entire reference, Goetz et al teaches III-V nitride layers made of doped GaN, InGaN or AlGaIn and the composition and/or doping of the various layers may be smoothly graded over a finite thickness or may be graded over the entire thickness of the layer. Goetz et al also teaches a Si dopant (col 3, ln 1-67 and col 4, ln 1-67). Goetz et al also teaches a substrate **11** of sapphire, silicon carbide,

Art Unit: 1765

silicon or gallium arsenide or gallium nitride and depositing a buffer layer **12**, thereon (col 3, ln 20-35). It would have been obvious to a person of ordinary skill in the art at the time of the invention to modify Edmond et al or Redwing et al with Goetz et al's substrate of silicon because substitution of known equivalents for the same purpose is held to be obvious. (MPEP 2144.06).

Applicant is reminded that claims 2, 4-9, 16-17, 35 are product by process claims and are not limited to the manipulations of the recited steps, only the structure of the implied steps. Even though the product-by-process claims are limited by and defined by the process, determination of the patentability is based on the product itself. If the product in the product by process claim is the same or obvious from a product of the prior art, the claim is unpatentable even though the prior product was made by a different process (MPEP 2113).

Referring to claim 2, 4-9 and 35, the instant claims only further limit the process of the invention. Edmond et al teaches the structure of instantly claimed product.

Referring to claim 2, Redwing et al is silent to MOCVD. It is inherent to Redwing et al to deposit the graded gallium nitride layer using MOCVD because Redwing et al teaches deposition of a graded gallium nitride layer using metal organic (MO) precursors.

Referring to claims 4-7, Redwing et al disclose changing the total flow of precursors (Fig 20).

Referring to claims 11-14, the combination of Edmond et al and Goetz et al or the combination of Redwing et al and Goetz et al teaches a buffer layer is graded from AlN at the substrate to GaN at the top ('747 col 24, ln 60-65 and '554 col 7, ln 10-20).

Referring to claims 16-17, Redwing et al discloses an AlGaInN graded layer.

Art Unit: 1765

Referring to claim 16-17, the combination of Edmond et al and Goetz et al teaches donor species are introduced simultaneously to stabilize the structural integrity of a heteroepitaxially grown III-V nitride on lattice mismatched substrates ('393 col 5, ln 30-65).

Referring to claim 36, the combination of Edmond et al and Goetz et al or the combination of Redwing et al and Goetz et al teaches the thickness of the graded buffer layer may range from 200 angstroms to 5 micrometers ('747 col 22, ln 55-60)

Referring to claim 37-39, the combination of Edmond et al and Goetz et al or the combination of Redwing et al and Goetz et al discloses a graded AlGaN layer from an AlN layer to a GaN, but is silent to the graded gallium nitride layer has a net compressive stress. It is inherent to the combination of Edmond et al and Goetz et al or the combination of Redwing et al and Goetz et al to have a net compressive stress because the differences in lattice constant throughout the graded layer inherently causes compressive stress.

Referring to claims 38, the combination of Edmond et al and Goetz et al or the combination of Redwing et al and Goetz et al discloses a graded AlGaN layer from an AlN layer to a GaN, as applicant, but is silent to the graded layer has a net stress below a stress required for crack generation. This is inherent to the combination of Edmond et al and Goetz et al or the combination of Redwing et al and Goetz et al because the graded buffer layers are used to grow gallium nitride layers without cracks ('747 col 25, ln 5-20). Furthermore, doped layer will not crack when grown to a proper thickness, which can be determined by routine experimentation ('393 col 5, ln 35-45 and col 6, ln 1-10).

Referring to claim 39, the combination of Edmond et al and Goetz et al or the combination of Redwing et al and Goetz et al is silent to the stress required for crack generation

Art Unit: 1765

is less than about 400 Mpa in tension. This is inherent to the combination of Edmond et al and Goetz et al or the combination of Redwing et al and Goetz et al discloses a graded AlGaN layer from an AlN layer to a GaN, as applicant.

Response to Arguments

7. Applicant's arguments with respect to claims 1, 2, 4-9, 11-17 and 35-39 have been considered but are moot in view of the new ground(s) of rejection.

8. Applicant's argument that Goetz lacks any discussion about a graded gallium nitride layer on a silicon substrate is noted but is not found persuasive. Goetz teaches a silicon substrate **11** and a buffer layer **12**. Goetz also teaches the composition of various layers may be smoothly graded over a finite thickness, which would include grading the composition of buffer layer (col 3, ln 20 to col 4, ln 5).

Conclusion

9. The prior art made of record and not relied upon is considered pertinent to applicant's disclosure.

Yoshida (US 5,496,767) teaches a compressive stress is applied to an active layer by a strain due to a difference between lattice constants of the active layer to a substrate (col 1).

Kamiyama et al (US 6,324,200) teaches adding arsenic to the composition of a Group III-V nitride semiconductor results in a shallower acceptor level, as compared to nitride semiconductors without added Arsenic (col 10, ln 1-67).

Art Unit: 1765

Okumura (EP 1 022 825 A1) teaches a SiC substrate or a Si substrate and a buffer layer of GaN or a ternary mixed crystal may be deposited thereon ([0057]).

Weeks, JR et al (US 2002/0074552) claims a similar product as instantly claimed by applicant, note claims 1-53.

Solomon (US 6,146,457) teaches a Si substrate is chosen for the deposition of GaN because it can easily be manufactured to very small thicknesses (col 6, ln 35-45).

Hirosawa et al ("Growth of single crystal $\text{Al}_x\text{Ga}_{1-x}\text{N}$ Films on Si Substrates by Metalorganic Vapor Phase Epitaxy) teaches a Si substrate is used for the deposition of $\text{Al}_x\text{Ga}_{1-x}\text{N}$ films because Si substrates are of high quality, large size and low cost (Introduction).

10. Applicant's amendment necessitated the new ground(s) of rejection presented in this Office action. Accordingly, **THIS ACTION IS MADE FINAL**. See MPEP § 706.07(a). Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

A shortened statutory period for reply to this final action is set to expire THREE MONTHS from the mailing date of this action. In the event a first reply is filed within TWO MONTHS of the mailing date of this final action and the advisory action is not mailed until after the end of the THREE-MONTH shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of the advisory action. In no event, however, will the statutory period for reply expire later than SIX MONTHS from the date of this final action.

Art Unit: 1765


11. Any inquiry concerning this communication or earlier communications from the examiner should be directed to Matthew J Song whose telephone number is 703-305-4953. The examiner can normally be reached on M-F 9:00-5:00.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Benjamin L Utech can be reached on 703-308-3868. The fax phone numbers for the organization where this application or proceeding is assigned are 703-872-9310 for regular communications and 703-872-9311 for After Final communications.

Any inquiry of a general nature or relating to the status of this application or proceeding should be directed to the receptionist whose telephone number is 703-308-0661.

Matthew J Song
Examiner
Art Unit 1765

MJS
July 16, 2003


BENJAMIN L. UTECH
SUPERVISORY PATENT EXAMINER
TECHNOLOGY CENTER 1700